

Metal Digital Direct Manufacturing (MDDM) for Close-Out of Combustion Chambers and Nozzle Fabrications, Phase II

Completed Technology Project (2016 - 2020)



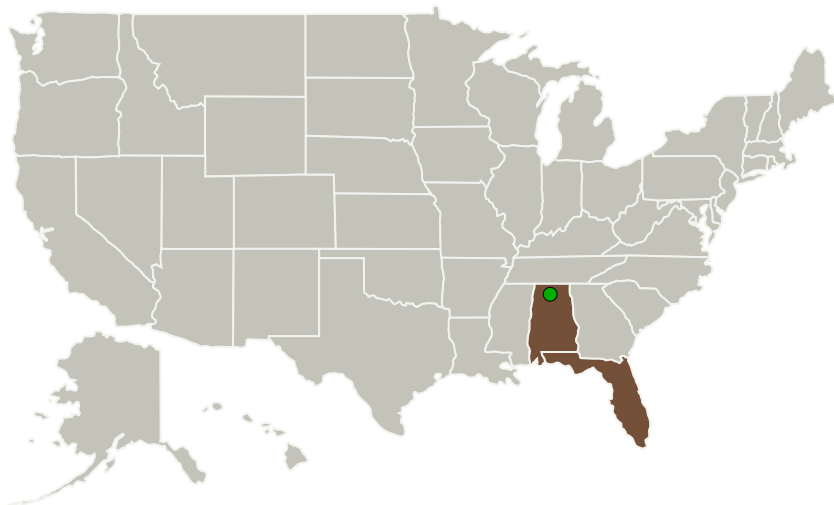
Project Introduction

This NASA sponsored STTR project will investigate methods for close-out of large, liquid rocket engine, nickel or stainless steel nozzle, coolant channels utilizing robotic laser and pulsed-arc additive manufacturing (AM) methods. Structural jacket to coolant channel land area interface strength will be quantified and metallurgical characterization completed. Process optimizations will be conducted to select best deposition parameters and starting feed stock for the AM processes based on article pressure drop and pressure testing. Sub-scale and intermediate size nozzles will be fabricated using the hybrid Metal Digital Direct Manufacturing (MDDM) processes and delivered to the NASA-MSFC for hot fire testing. Value stream analysis and process cost modeling methods will be used to estimate nozzle should costs and to identify relative economic risk of each nozzle AM operation.

Anticipated Benefits

Potential NASA applications include large liquid rocket engine combustion chambers and nozzles. Proposed process will enable elimination of current electrochemical plating methods for close-out of coolant channels in regeneratively cooled components utilized in liquid rocket engines. This technology has the potential to offer significant cost and time reductions for manufacturing of these types of components. Potential Non-NASA applications include large liquid rocket engine combustion chambers and nozzles.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Keystone Synergistic Enterprises, Inc.	Lead Organization	Industry	Port Saint Lucie, Florida
● Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Florida

Project Transitions

▶ **November 2016:** Project Start

✓ **August 2020:** Closed out

Closeout Documentation:

- Final Summary Chart PDF(<https://techport.nasa.gov/file/140890>)

✓ **August 2020:** Closed out

Closeout Documentation:

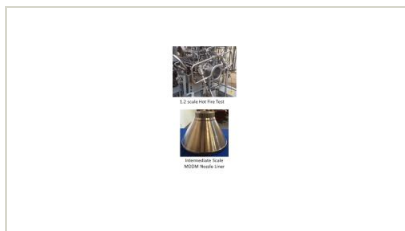
- Final Summary Chart(<https://techport.nasa.gov/file/140889>)

Images



Briefing Chart Image

Metal Digital Direct Manufacturing (MDDM) for Close-Out of Combustion Chambers and Nozzle Fabrications, Phase II
(<https://techport.nasa.gov/image/131550>)



Final Summary Chart Image

Metal Digital Direct Manufacturing (MDDM) for Close-Out of Combustion Chambers and Nozzle Fabrications, Phase II
(<https://techport.nasa.gov/image/131132>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Keystone Synergistic Enterprises, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

Gwenevere L Jasper
Paul R Gradl

Principal Investigator:

Bryant Walker

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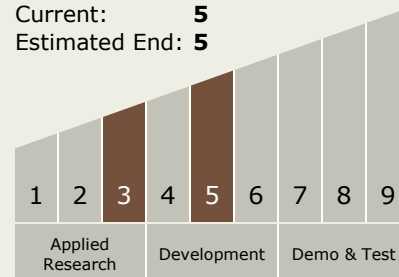


Final Summary Chart Image

Metal Digital Direct Manufacturing (MDDM) for Close-Out of Combustion Chambers and Nozzle Fabrications, Phase II
(<https://techport.nasa.gov/image/132063>)

Technology Maturity (TRL)

Start: 3
Current: 5
Estimated End: 5



Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System